TITLE:	CONTROL OF INTERFACIAL DUST CAKE TO IMPROVE EFFICIENCY OF MOVING BED GRANULAR FILTERS
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ABSTRACT

OBJECTIVE

The goal of this research is to improve the performance of moving bed granular filters for hot gas clean-up of fine particles. We have developed a new concept for a moving bed granular filter based on observations by other researchers of the importance of the formation of a dust cake on dust collection efficiency. The method is suitable for advanced coal-fired boilers at high pressures and temperatures. The specific objectives of the research include:

- Understand the interfacial phenomena of dust cake formation
- Develop performance correlations applicable to high temperatures and pressures
- Develop granular filters that exploit dust cakes to improve collection efficiency

The research centers on measurements taken from a moving granular bed designed to handle pressures up to about 27 psig in which the important parameters of filtration (mass flow rates, particle concentrations, particle size, bed pressure drop etc.) are measured under controlled conditions at room temperature. Performance at high temperatures and extended pressures are inferred by dimensionless correlations by preserving the hydrodynamic flow properties.

ACCOMPLISHMENTS TO DATE

1. Construction of cold-flow model of moving bed granular filter completed. This facility allows simulation of the fluid dynamic conditions in a high temperature, high pressure environment typical of hot gas clean up systems.

2. Fabricated a pressurized feeder system. This system consists of a computer-controlled auger feeder enclosed within a pressure vessel and connected to the gas inlet line of the filter apparatus.

3. Installed data acquisition system. This system allows pressures and temperatures within the filter system to be monitored. It also measures laser beam attention for the particulate concentration measurement system.

4. Developed boroscopic/video system to monitor filter cake development at the gas/bed interface.

5. Developed a laser attenuation system for measuring particulate concentration consisting of beam splitter, (two) lasers, and photocells.

6. Calibrated instrumentation to be used in experiments including the feeder system, thermocouples, rotameters, and photodiodes.

7. Designed and installed control system to assure steady-flow of particulate through the experimental apparatus. This can be used to hold the concentration constant while testing the effect of the other parameters.

8. Mounted accessories such as pitot tubes, isokinetic sampling probes, and pumps.

9. Installed emergency shut-off valves to rapidly depressurize the experimental rig under emergency conditions.

10. Constructed expansion chamber to prevent dust flow into room if pressure relief valve opens.

SIGNIFICANCE TO FOSSIL ENERGY PROGRAMS

Advanced coal-fired power cycles under development by the U.S. Department of Energy include pressurized fluidized bed combustion and integrated gasification/ combined cycles based on gas turbines and fuel cells. All of these advanced cycles are premised on the efficient removal of fine particles from high temperature, high pressure (HTHP) gas streams. Several methods are available for removing particles from gas streams including cyclone separators, barrier filters, electrostatic separators, scrubbers, acoustical or thermal agglomeration, and granular bed filters. Recent analyses suggest that ceramic candle barrier filters and granular bed filters are the most promising approaches to hot-gas clean-up for advanced coal conversion technologies. Granular bed filters are attractive for hot gas filtration because they employ low-cost refractory granules as filter media.

PLANS FOR THE COMING YEAR

Parametric studies will be performed to determine the effect of various operating parameters on collection efficiencies and pressure drops across the moving bed filters. Functional dependence of the following parameters will be included: interfacial geometry of the filter, dust loading in the filter, mass flow rate of granules, gas flow rate, granule size for different filtration regimes (inertial impaction, Brownian diffusion, gravitation settling). Performance correlations will be developed in terms of appropriate dimensionless parameters.

Experiments will be performed to understand the role of dust cake formation on the collection efficiency of granular beds. Filtration experiments will be performed using the special bed media (low-melting point granules and/or pre-sintered granules). Sintered bed media will be recovered from the granular bed filters and microscopically examined to determine dust profiles. SEM microphotographs and computer tomography (CT) will be employed to obtain these profiles. Electrostatic control of particulate will also be evaluated.

ARTICLES, PRESENTATION, AND STUDENT SUPPORT

Journal Articles (peer reviewed): none

Conference Presentations (peer reviewed):

Brown, R. C., Smeenk, J., and Wistrom, C., "Design of a moving bed granular filter for biomass gasification," Proceedings of the Progress in Thermochemical Biomass Conversion Conference, Tyrol, Austria, September 17-22, 2000.

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